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lence and fidelity of Dr. Lillie's figures. The last two sections of the chapter, describing the mesoblast of the opaque area and the germ wall, are very satisfactory. The chapter as a whole is a good account of the origin of the mesoderm.

The fifth chapter, Head-fold to Twelve Somites, is divided into parts upon the head-fold, fore-gut, neural tube, mesoblast and an embryo with ten somites. The attempt to describe the growing embryo, as a whole, breaks down in this chapter, and it might have been better to begin the part upon organogeny at the end of this chapter or earlier instead of after the next chapter. As it stands, portions of this chapter and of the next anticipate statements which are made later.

The second part of the book contains, in addition to chapters on each organ-system, a chapter on the external form of the embryonic membranes and one on the body cavities, mesenteries and septum transversum. There is an extensive and useful bibliography.

The book contains the inevitable errors of a first edition. There is no mention of the origin of the feathers, of the lymphatic vessels and of the muscles of the eye. The anterior division of the embryonic heart is called the bulbus arteriosus, or the bulbus, in the text, index and the original figures, but is named the bulbus cordis in copied figures. The choroid fissure is said to provide "an aperture in the wall of the optic cup for the entrance of the arteria centralis retinae" (p. 166), but the author himself says elsewhere "There is no arteria centralis retinae in the bird's eye" (p. 281). Happily such slips are infrequent.

The book contains a large amount of new material, for in addition to the second and fourth chapters upon the development of the egg before laying and upon the origin of the mesoderm, which embody difficult and fundamental research, it makes many small contributions to our knowledge of the embryology of the chick. The value of the book is greatly enhanced by this original matter, which, although it usually serves only to decide between conflicting opinions or to add small details, and although in conformity with the purpose

of the book discussion of the literature and of interpretation is reduced to a minimum, gives a great store of facts that will be constantly referred to by students of embryology.

The numerous figures are well chosen and executed, but the publishers have poorly reproduced a number of them. More than half of the figures are new and among these are some very excellent drawings of whole embryos, and new diagrams of the structure of the egg and of the embryonic membranes. Some of the figures of sections could well be replaced by drawings of models.

The typography of the book is unusually good.

Professor Lillie's book, being a comprehensive and accurate statement of the processes by which the body and organs of a single animal are formed, will be of great service in the class-room where the careful observation and correlation of phenomena giving a training in true scientific method, are of more value than a broad and vague knowledge of many things and theories.

LEONARD W. WILLIAMS

A Canyon Voyage. By FREDERICK S. DELLENBAUGH. New York, Putnams. 1908. 50 plates.

Major Powell's "Exploration of the Colorado River of the West" is famous as a daring enterprise of forty years ago. His first river voyage in 1869 was briefly chronicled in his official report of 1875, and described in a more general manner in a popular book of later issue. His second voyage through the canyon in 1871 from the same starting point at Green River, has never been adequately described, although the results of observations then made were incorporated in the report above cited. At this late date, Dellenbaugh, a member of the second party, who has already written the "Romance of the Colorado River," in which earlier explorations are described, now gives us what he regards as a sequel to his previous book, in the form of a minute narrative of the second boat trip down the river, when he was artist and assistant topographer of the party. There is no attempt at scientific discussion, but a faithful effort is made to record every

item of the journey. In these later years, when amateur travel in the west is frequent, a detailed record of this kind will be of value to seekers after adventure; even if certain parts of the river are unduly dangerous, there are other long stretches in which a boat trip might well be undertaken in a summer vacation without too great disregard of a safe return home. Whether made by scientist, hunter or artist, the journey would surely be repaying in high degree, as one may be assured from the plates, as well as from Dellenbaugh's vivid descriptions. The solitude must be impressive as one floats down the smooth reaches beneath a mighty architecture of bare cliffs. The excitement of running rapids would seem to be sufficient for the most ardent seeker of new impressions. Many of the plates are excellent, although reproduced from photographs taken nearly forty years ago.

W. M. D.

SPECIAL ARTICLES

THE POSSIBLE ANCESTORS OF THE HORSES LIVING UNDER DOMESTICATION¹

DURING the later part of the nineteenth century, it was generally taken for granted (1) that "the seven or eight species of Equidæ now existing are all descended from an ancestor of a dun colour more or less striped";² (2) that the common ancestor of the living horses, asses and zebras was connected by a single line of descent with the four-toed "fossil" horses of the Eocene period; (3) that the domestic horses are descended from Pleistocene species characterized by large molars with a long anterior internal pillar, a large heavy head and coarse limbs; (4) that in various parts of Europe and Asia, domestic races increased in size and were improved in make, speed and disposition, as a result of artificial selection and favorable surroundings.

On the continent it seems to be still generally assumed that the domestic breeds have descended from a single species,³ but in Eng-

¹ Abstract of a paper presented to the Royal Society, London.

² Darwin, "Animals and Plants," Vol. II., p. 17.

³ The latest suggestion is that domestic horses are the descendants of *Equus fossilis* Rüttimeyer,

land and America many naturalists now believe: (1) That domestic horses have sprung from several wild species connected by several lines of descent with the three-hoofed "fossil horses" of the Miocene period, and (2) that while some of the wild ancestors were adapted for living in the vicinity of forests and upland valleys, others were adapted for a steppe, plateau or desert life.

Of possible ancestors of the domestic breeds, the following may be mentioned: *Equus sivalensis*, *E. stenonis*, *E. gracilis* (Owen's *Asinus fossilis*), *E. namadicus*,⁴ *E. fossilis* and *E. robustus*.

These species mainly differ in the teeth, size and deflection of the face and in the bones of the limbs. In the first three species the grinding surface of the anterior internal pillar (a fold of enamel on the inner surface of the cheek teeth) of the premolars and first molar, is short—in the last premolar, pm. 4, it may only be one third the length of the crown—in the second three species the anterior internal pillar of pm. 4 and m. 1, is long—at least half the antero-posterior length of the crown. One of the ancestral types (*E. robustus*) was broad-browed and had a short face almost in a line with the cranium; another (*E. sivalensis*), also broad-browed, had a long tapering, strongly deflected face; a third (*E. fossilis*) had a long narrow face, not so strongly bent downwards as in *E. sivalensis*, and a fourth (*E. gracilis*) had a fine narrow, but only slightly deflected, face.

In *E. gracilis* the middle metacarpal (cannon bone) was so slender that the length was seven and a half times the width, while in *E. robustus* the length of the metacarpal was sometimes only five and a half times the width.

Of these possible ancestors, the first three occur in Pliocene deposits, the second three have only hitherto been found in Pleistocene deposits.

a Pleistocene species closely allied to the wild horse of Mongolia—*E. przewalskii*.

⁴ *E. namadicus* seems to be closely allied to *E. complicatus*, a species widely distributed in North America during the Pleistocene period.